

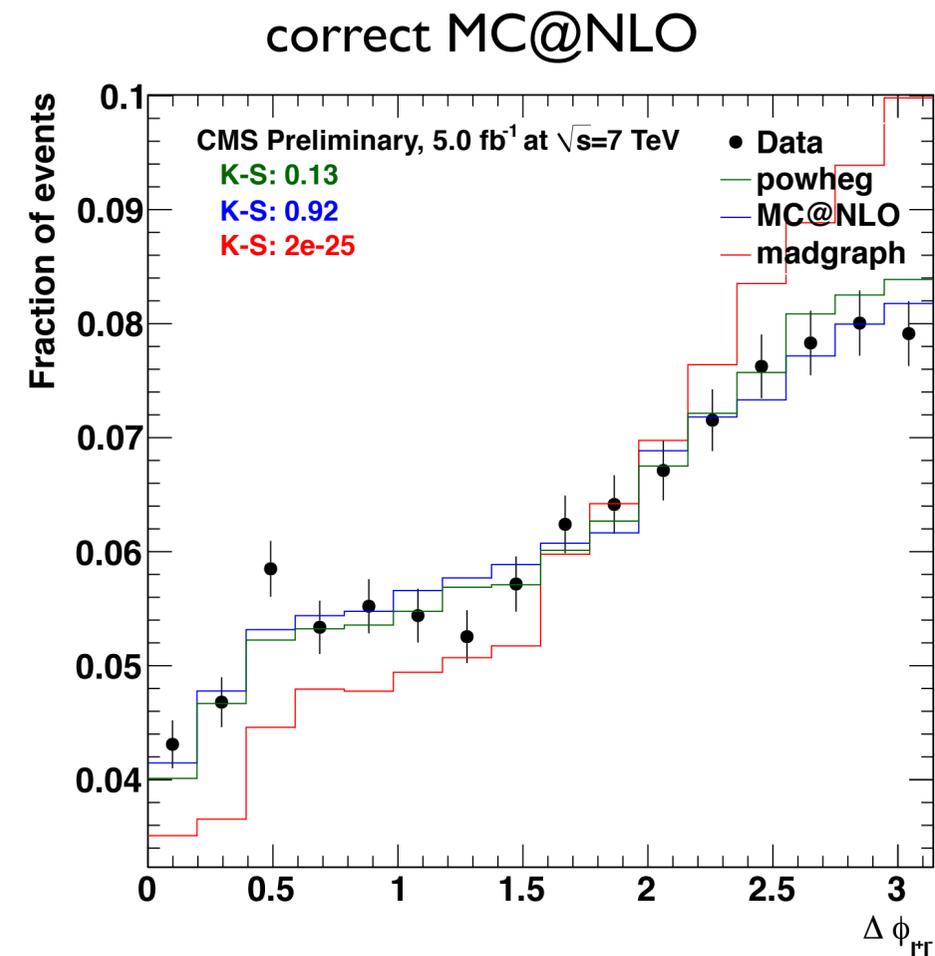
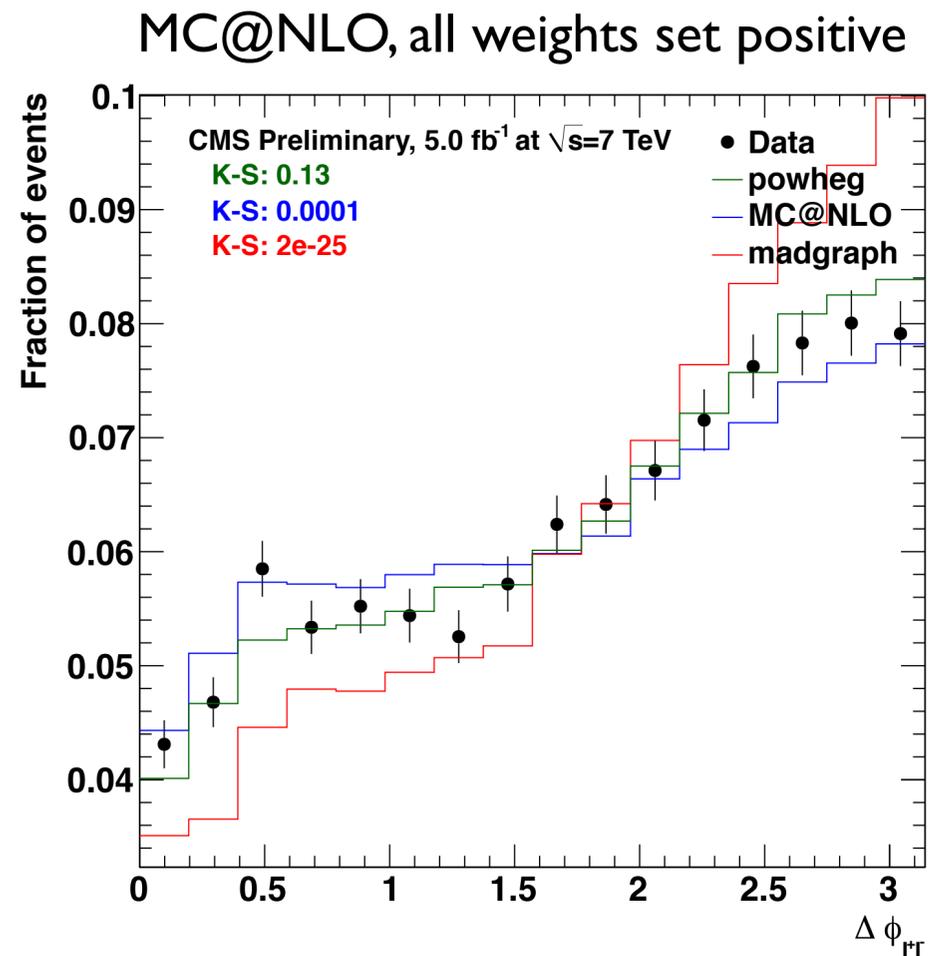
# $\Delta\phi_{||}$ distribution comparisons

# Introduction

- Found a bug in our code 2 weeks ago that was causing weights for all MC@NLO events to be set positive
- After fixing this we investigated the residual differences between MC@NLO and powheg

# Data-MC comparison (preselection)

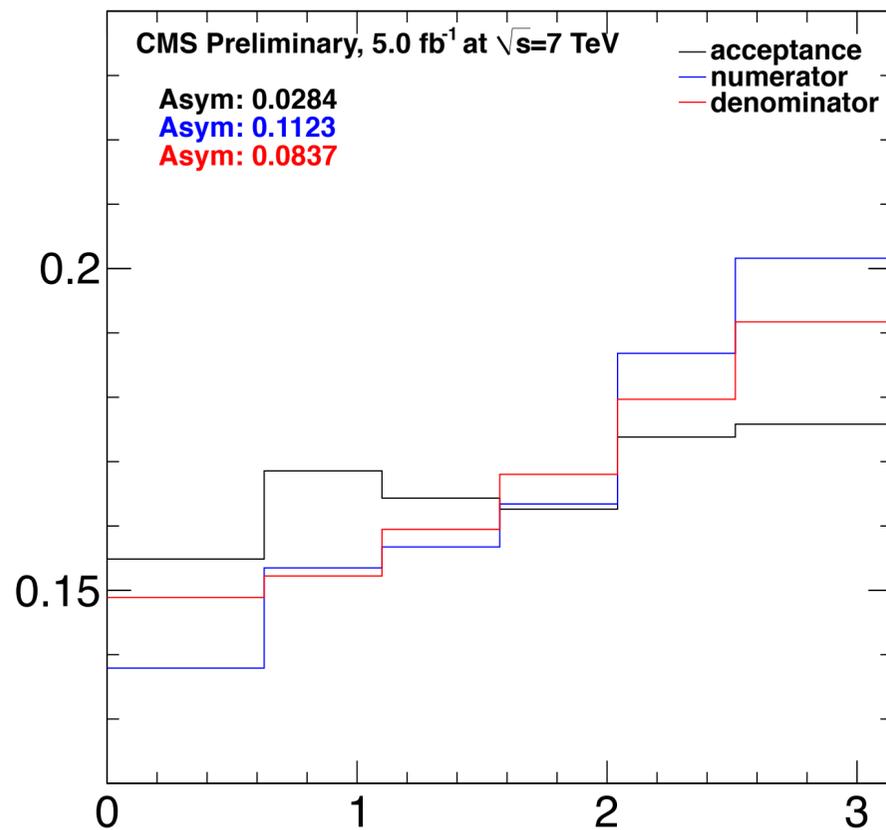
- Bug in our code caused weights for all MC@NLO events to be set positive
- Plots show data compared to sum of MC using 3 different samples for the dileptonic ttbar component, with the bug affecting MC@NLO (left) and after it was fixed (right)
  - all histograms are normalised to unity
- Significant improvement in the agreement between MC@NLO and data at the preselection level



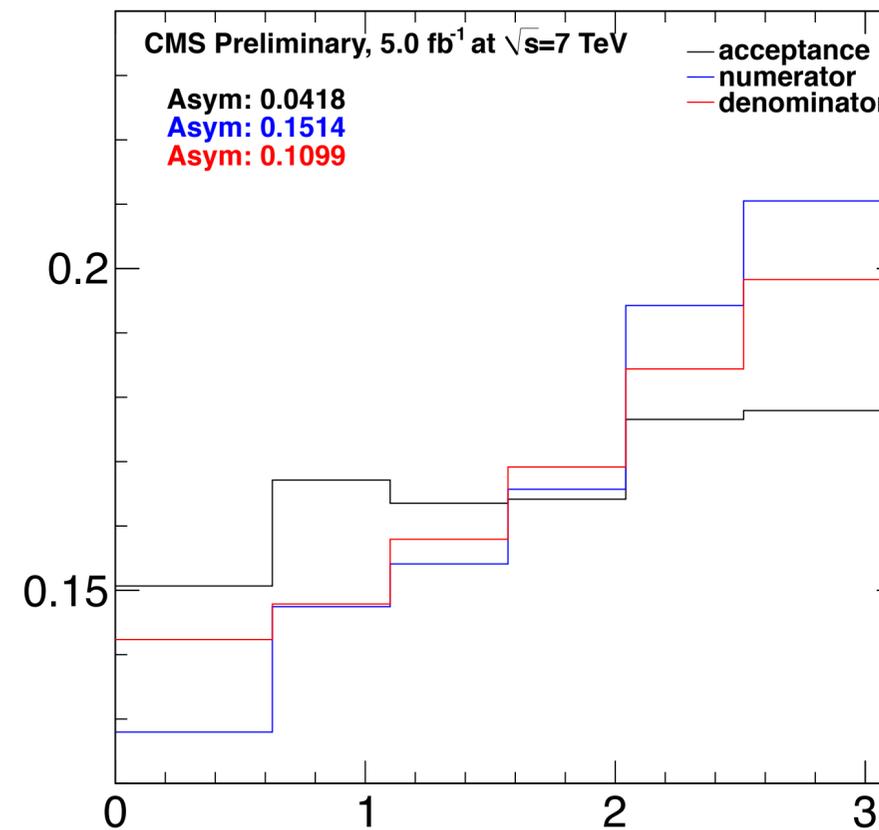
# Comparison before cuts, and acceptance

- Plots show numerator (preselection) and denominator (no cuts) histograms, and resulting acceptance histograms (again all normalised to 1)
- With correct weighting, MC@NLO denominator asym is close to powheg, but numerators not in agreement

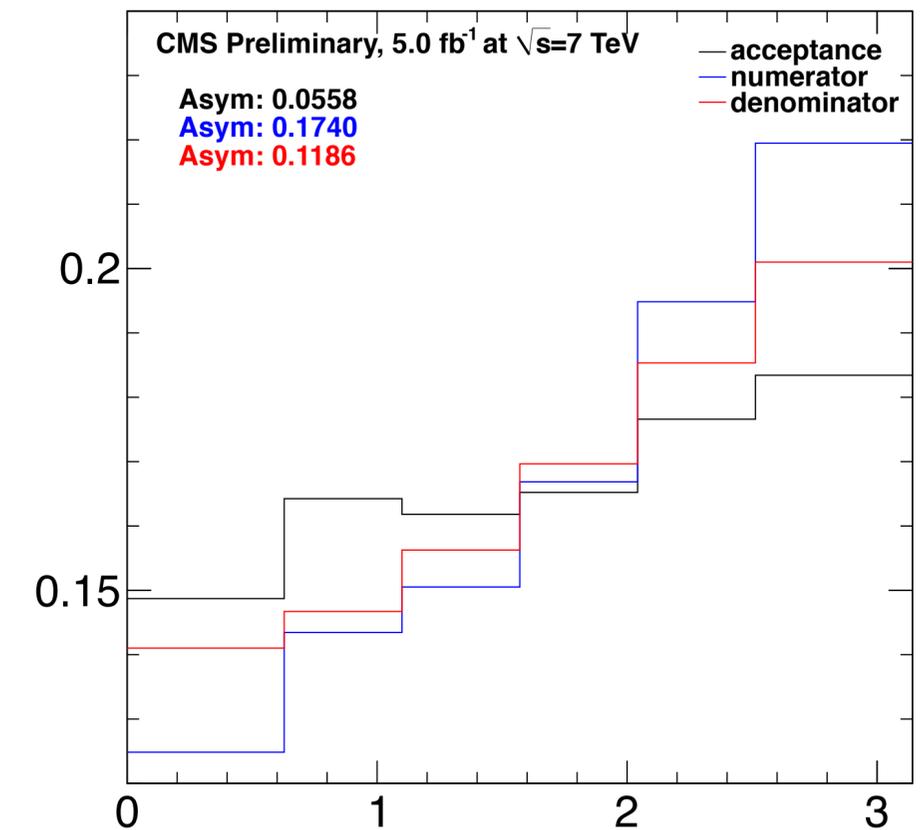
MC@NLO, all weights set positive



correct MC@NLO



powheg



$$\text{Asym} = (N_R - N_L) / (N_R + N_L)$$

# Comparison without taus

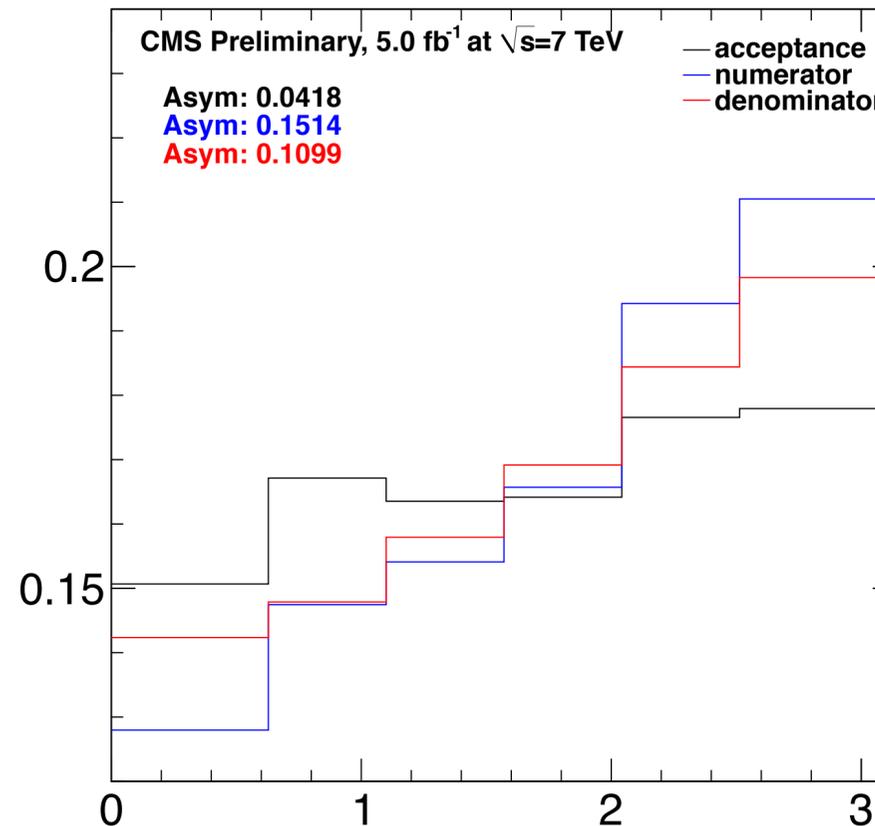
- It turns out that “leptonGenpCount\_lepTauDecays()” in our code cannot identify leptonic tau decays in MC@NLO
  - cms2.genps\_lepdaughter\_id()[jj].size() = 0 for all taus; result is that events with taus are omitted from MC@NLO
- Compare MC@NLO to powheg without taus: numerator (and thus acceptance) now similar
  - note, our current crude “modeling” systematic for  $\Delta\phi_{ll}$  comes mostly from the difference in acceptance asymmetries

**dumpDocLines() shows no Tau daughters for MC@NLO:**

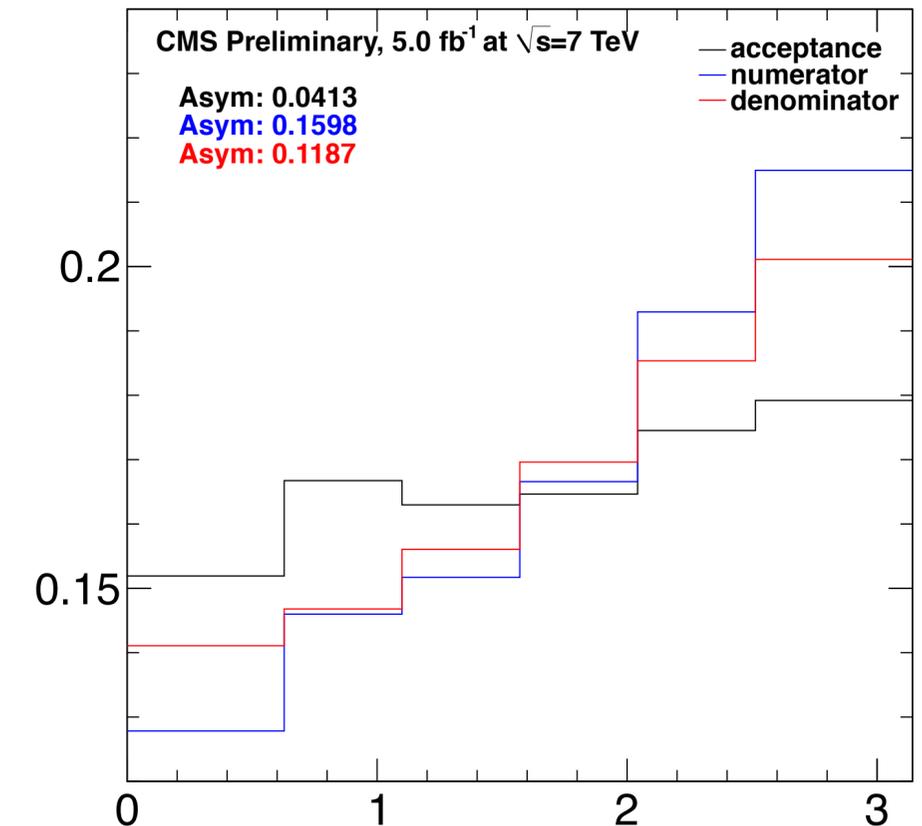
		pt	phi	eta	mass	status	Mother
0	d	0	0	2.317e+04	0.3062	3	proton
1	d_bar	0	0	-2.284e+04	0.3195	3	proton
2	t	63.68	1.623	1.205	171.9	3	d_bar
3	t_bar	51.17	-1.61	2.224	173.2	3	d_bar
4	b	66.2	0.3781	0.1664	4.95	3	t
5	W+	75.75	2.598	0.9704	80.7	3	t
6	b_bar	53.09	0.7425	1.317	4.95	3	t_bar
7	W-	96.17	-2.012	1.18	79.97	3	t_bar
8	tau+	77.74	2.398	0.3998	1.777	3	W+
9	nu_tau	15.45	-2.085	1.959	0	3	W+
10	tau-	34.89	-2.65	0.1594	1.777	3	W-
11	nu_tau_bar	71.24	-1.716	1.403	0	3	W-
12	c_bar	0	0	2.348e+04	1.541	3	c_bar
13	s_bar	0	0	-2.278e+04	0.5	3	s_bar
14	d	0	0	2.284e+04	0.3202	3	d
15	g	0	0	-2.276e+04	0.75	3	g

		pt	phi	eta	mass	status	Mother
0	g	0	0	2.438e+04	0.7071	3	proton
1	g	0	0	-2.278e+04	0.75	3	proton
2	t	11.35	-0.1939	5.364	138.2	3	g
3	t_bar	44.23	-1.078	2.881	172.5	3	g
4	b	36.52	-1.097	3.555	4.943	3	t
5	W+	30.34	1.749	3.635	83.34	3	t
6	b_bar	56.58	-1.804	0.6503	4.95	3	t_bar
7	W-	37.57	0.4422	2.938	69.68	3	t_bar
8	tau+	44.22	2.974	2.522	1.777	3	W+
9	nu_tau	44.34	0.5314	2.614	0	3	W+
10	tau-	28.76	1.864	1.689	1.777	3	W-
11	nu_tau_bar	43.8	-0.2647	2.548	0	3	W-

correct MC@NLO



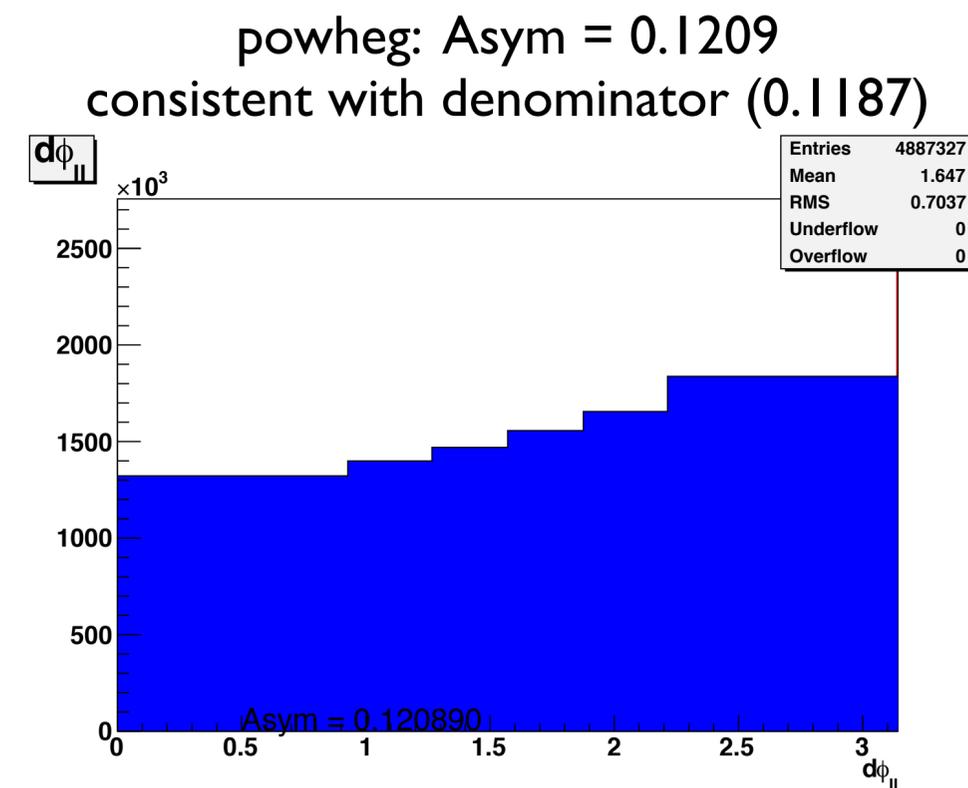
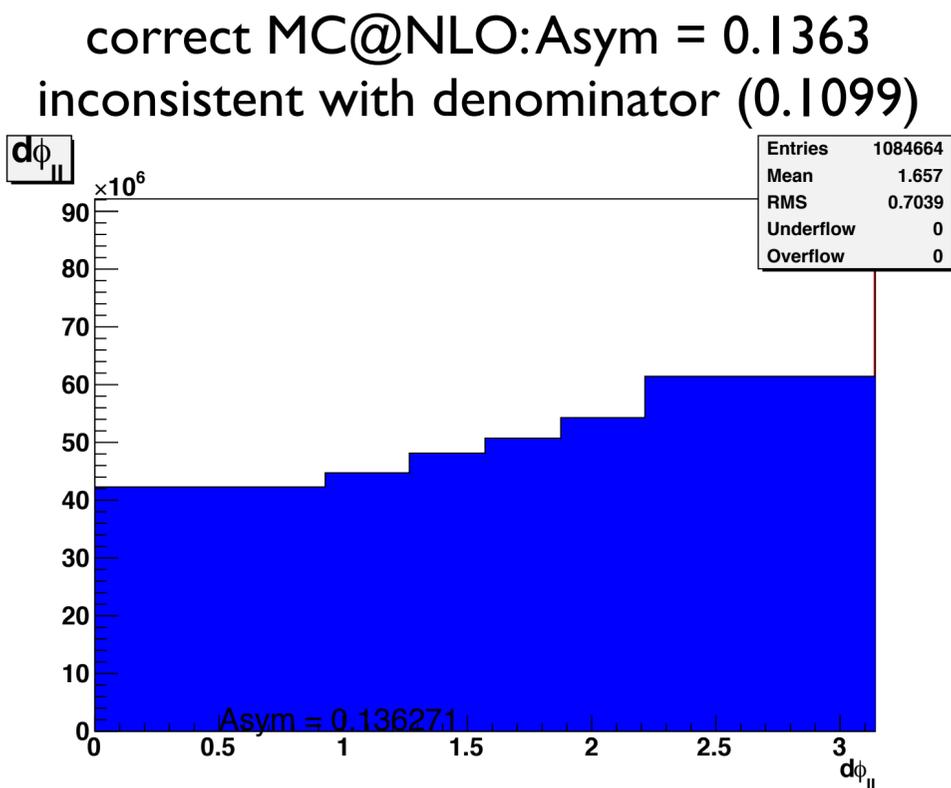
powheg, no Taus



$$\text{Asym} = (N_R - N_L) / (N_R + N_L)$$

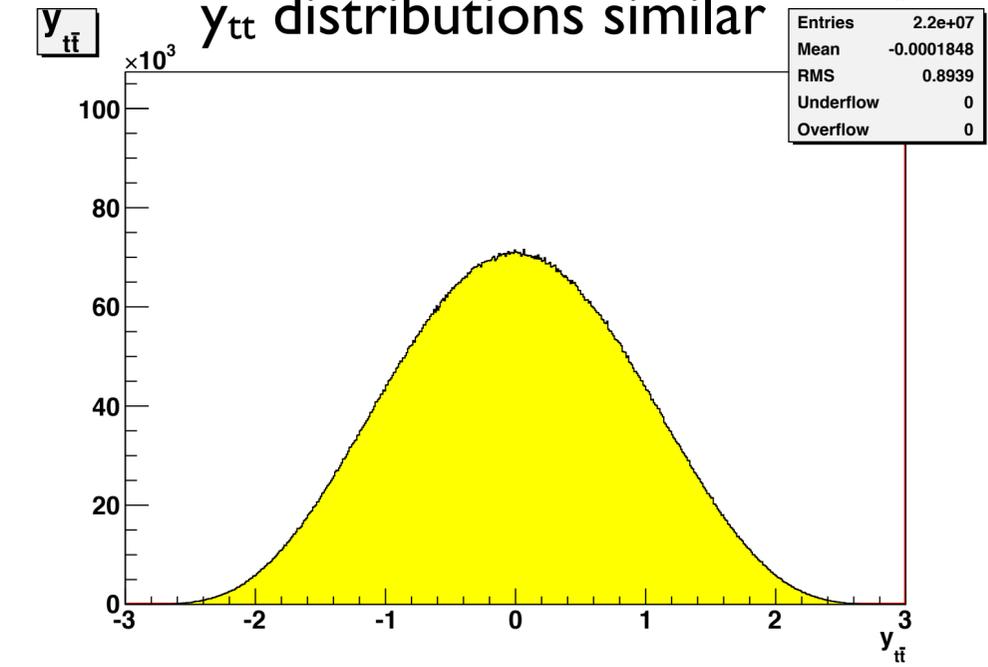
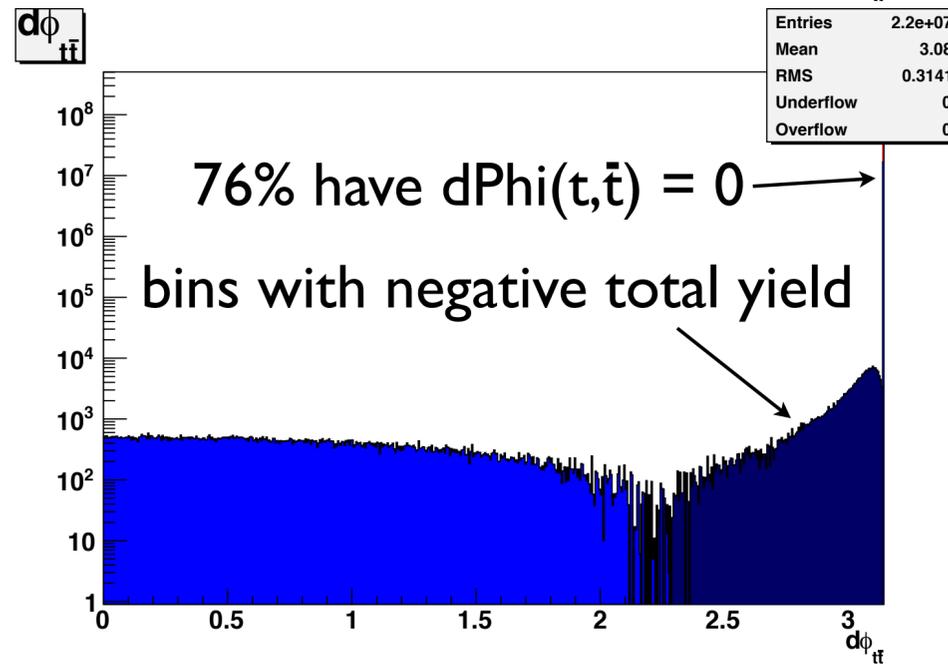
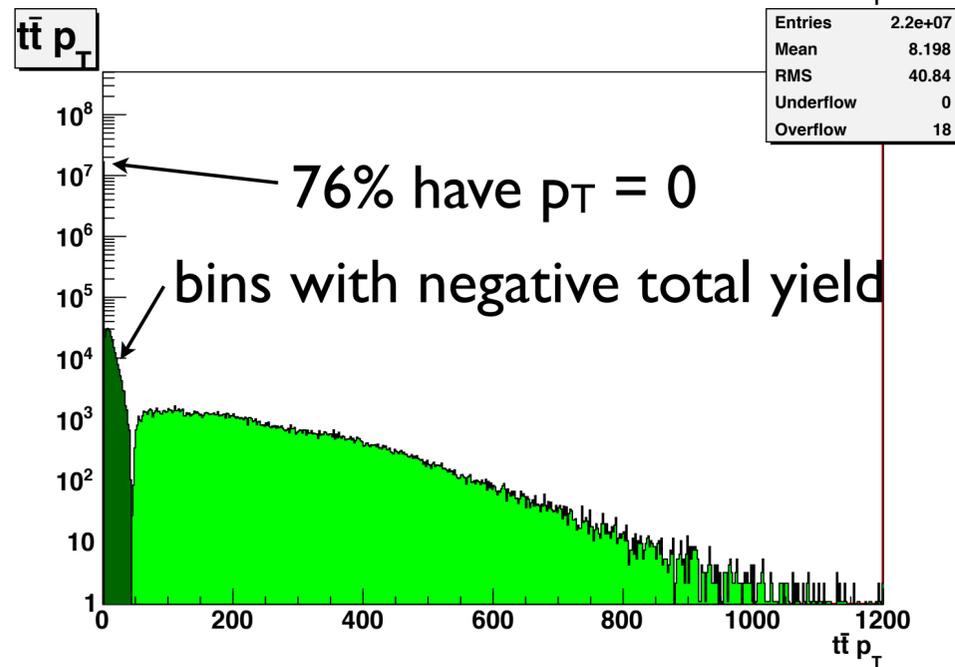
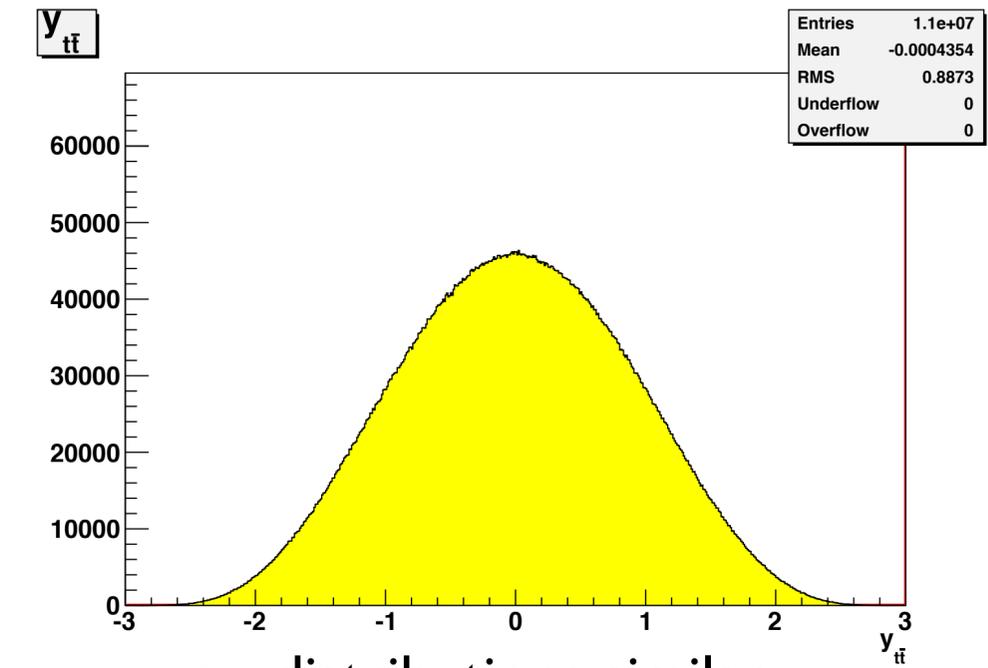
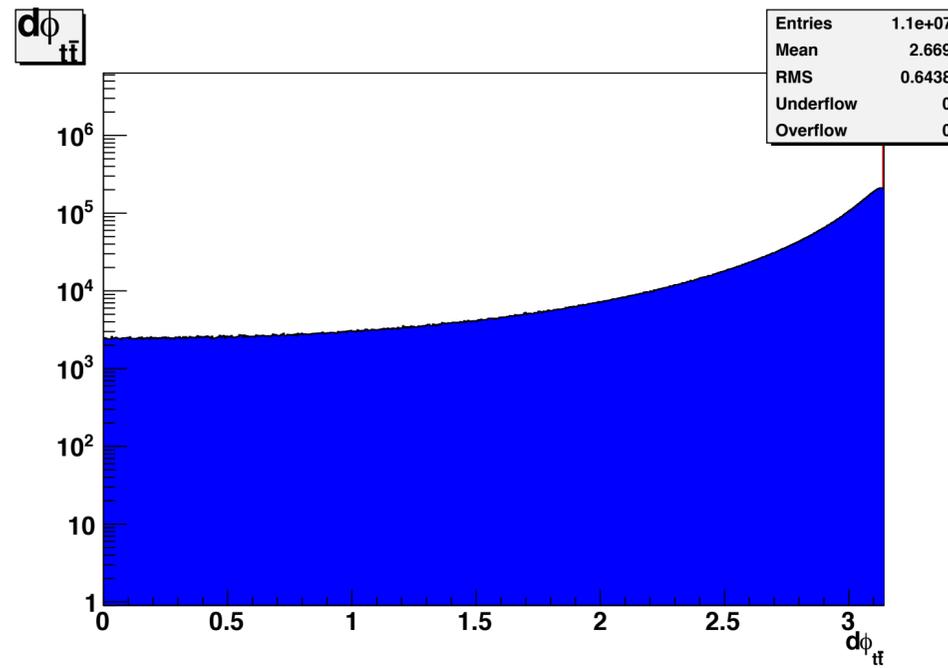
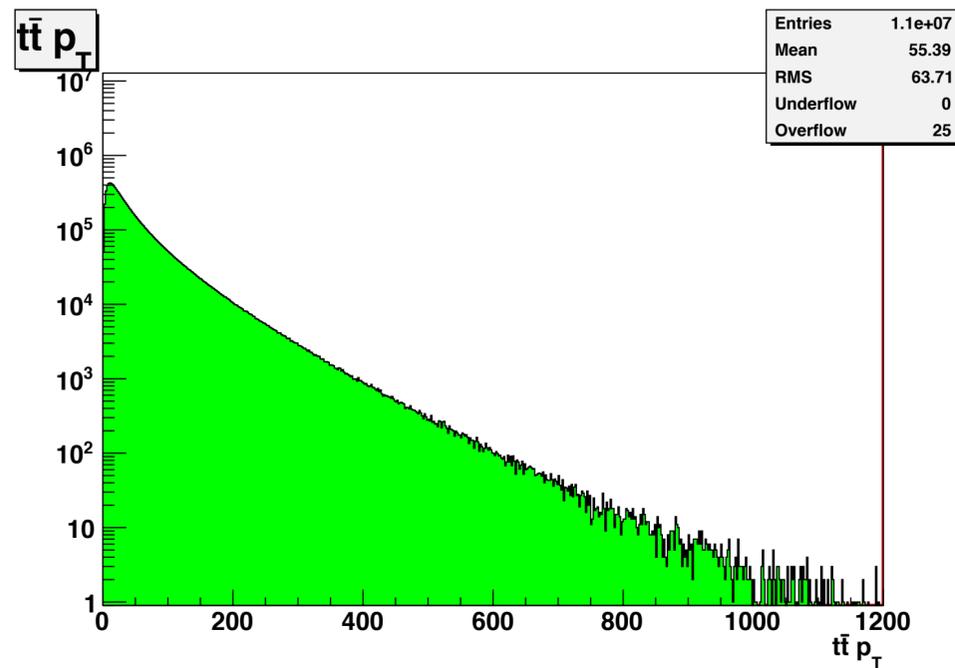
# Comparison at LHE level (excluding taus)

- Powheg result consistent with denominator on previous slide
- MC@NLO result inconsistent
- Powheg and MC@NLO results also inconsistent with each other
- Look in more detail at powheg vs MC@NLO at LHE level (next slide)



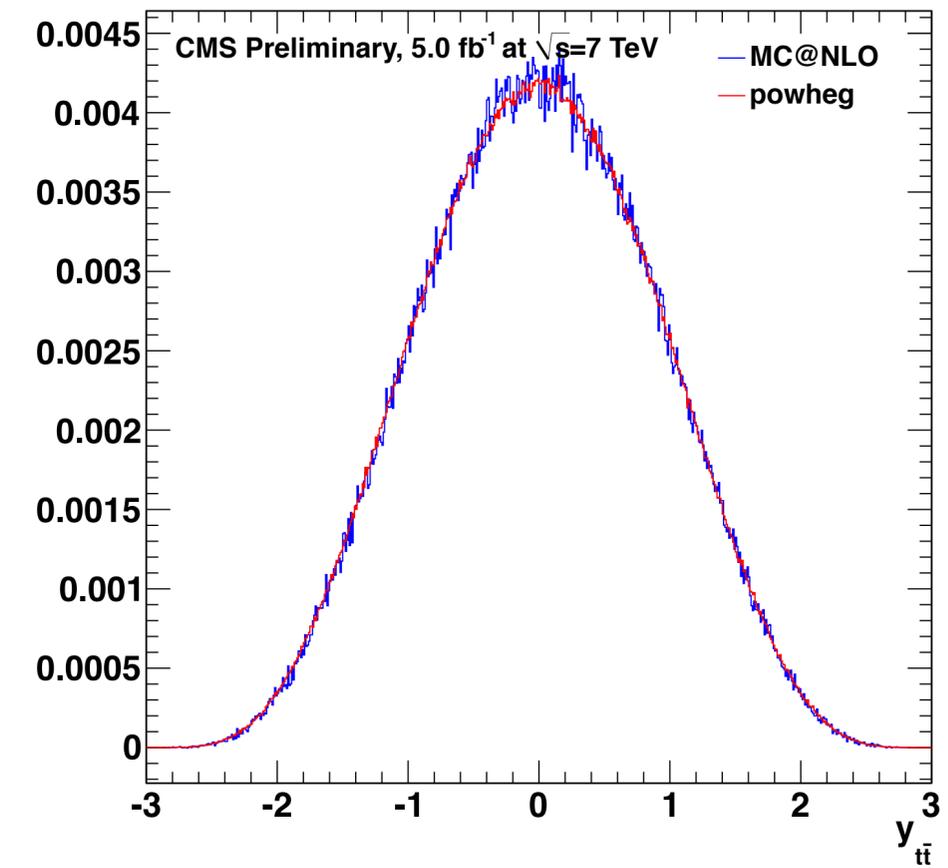
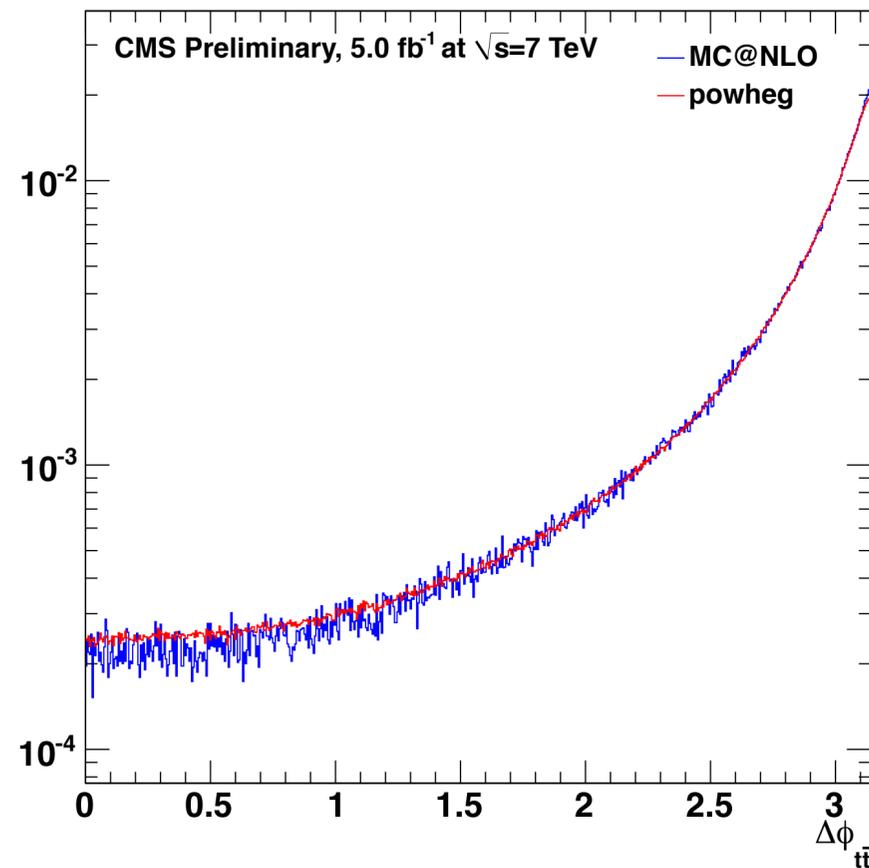
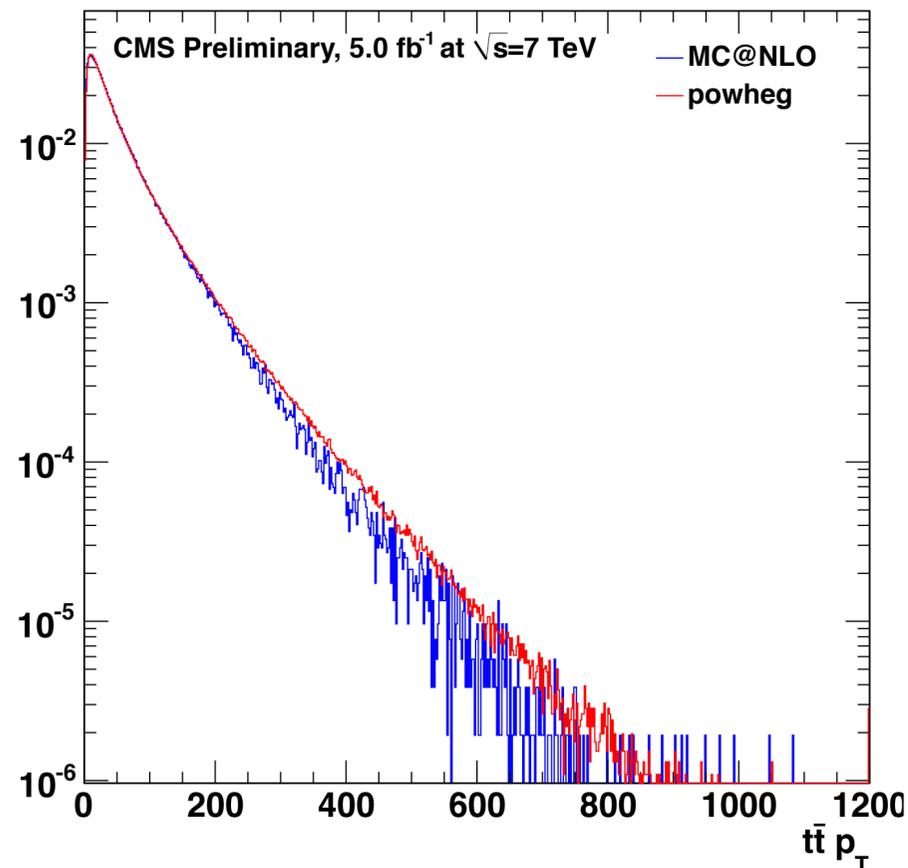
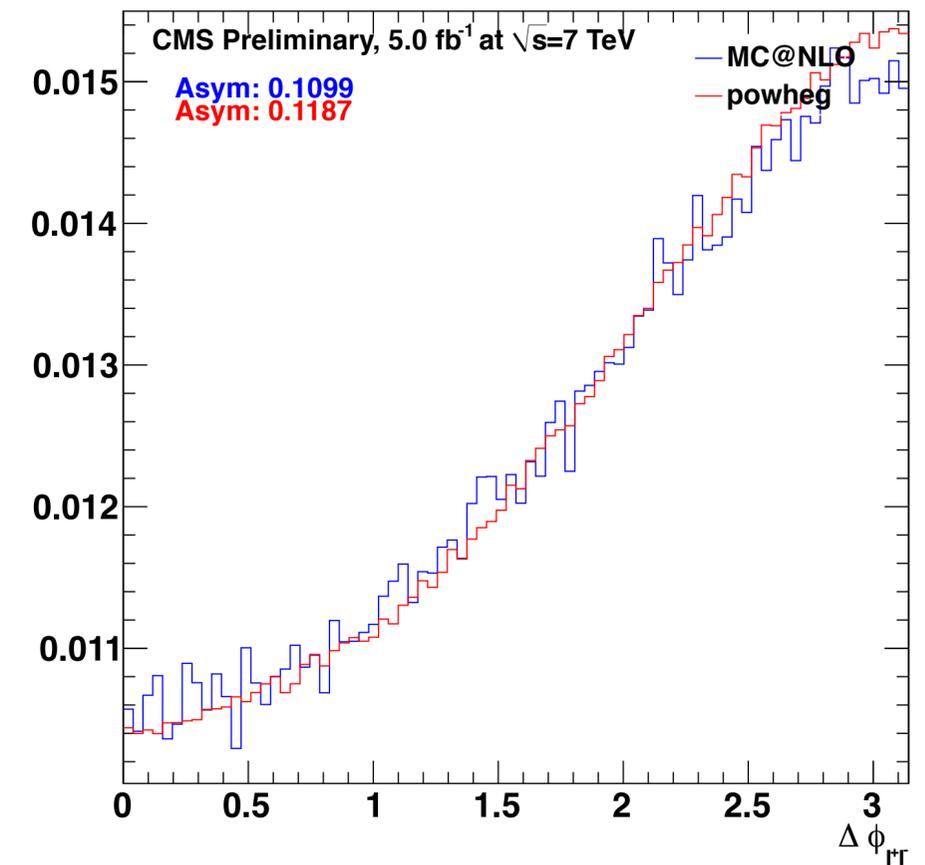
# ttbar system at LHE level in powheg and MC@NLO

- ttbar  $p_T$  distribution very different in powheg (top row) and MC@NLO (bottom row)
- 76% of MC@NLO events have ttbar  $p_T = 0$ , and some bins have negative total (denoted by darker shading)
- Is the MC@NLO discrepancy in lepton  $\Delta\phi$  between LHE and denominator caused by Herwig adjusting the ttbar  $p_T$  after IFSR?



# denominator level comparison

- **powheg** and **MC@NLO** (both without taus) look much more similar at denominator level
- Conclude that MC@NLO LHE distributions not comparable to denominator level distributions or powheg LHE distributions due to  $t\bar{t}$   $p_T$  rebalancing
- Lepton  $\Delta\phi$  distributions pretty compatible at denominator level (right):
- Need to work on selecting leptonically decaying taus from MC@NLO
  - but the problem of lost spin correlations in tau decays in MC@NLO would still remain

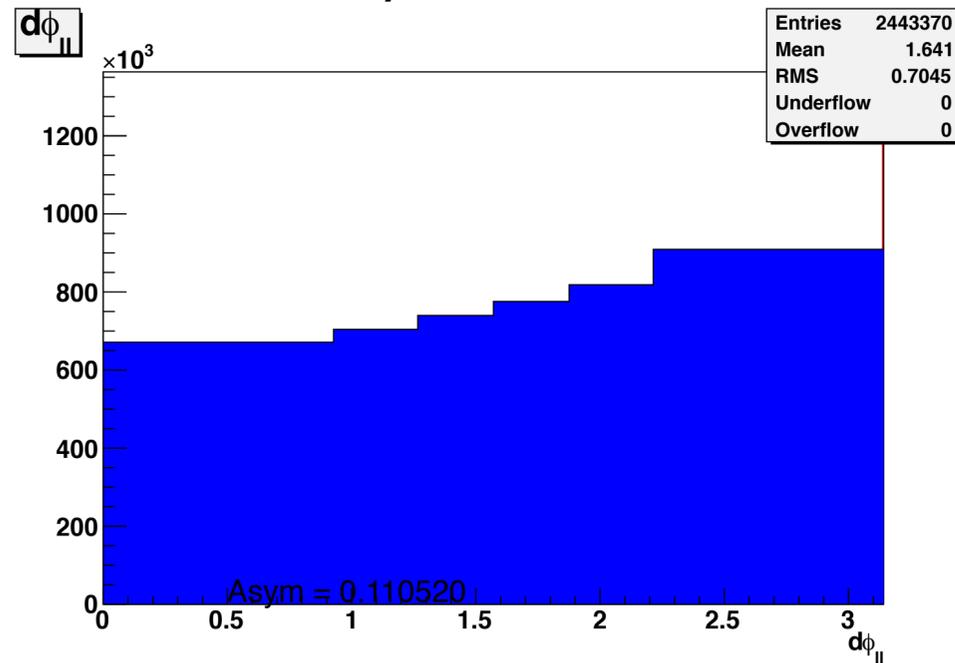


# Backup

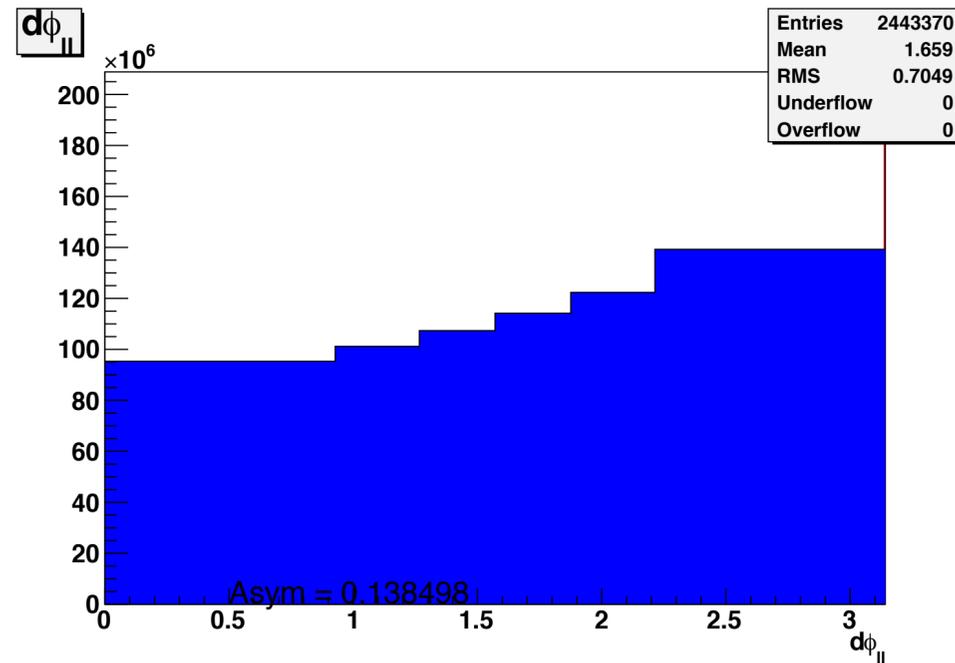
# Comparison at LHE level (including taus)

- Same as slide 6, but now including taus; the difference is negligible at LHE level

MC@NLO, all weights set positive:  
Asym = 0.1105



correct MC@NLO: Asym = 0.1385



powhcg: Asym = 0.1206  
consistent with denominator (0.1186)

